

2018-19 Winter Outlook

For Northern & Central New Mexico



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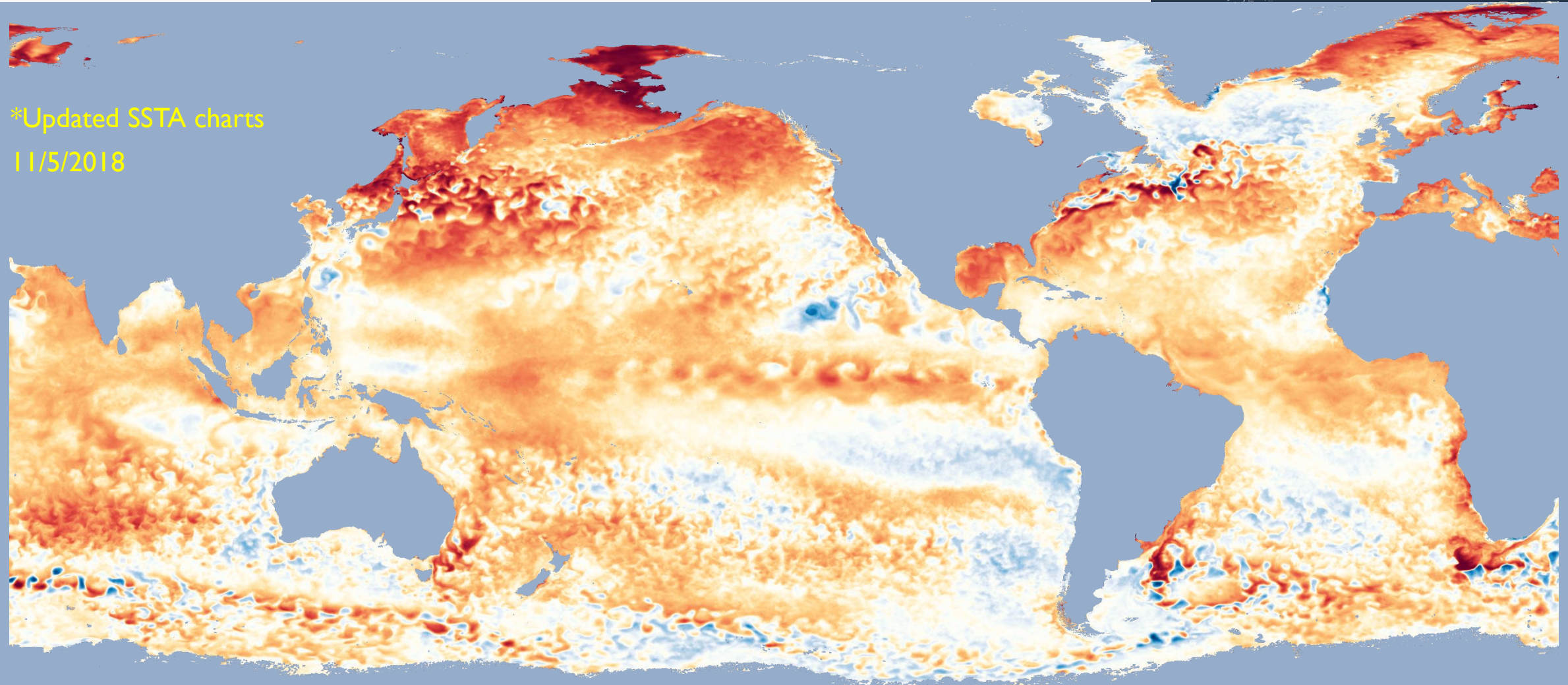


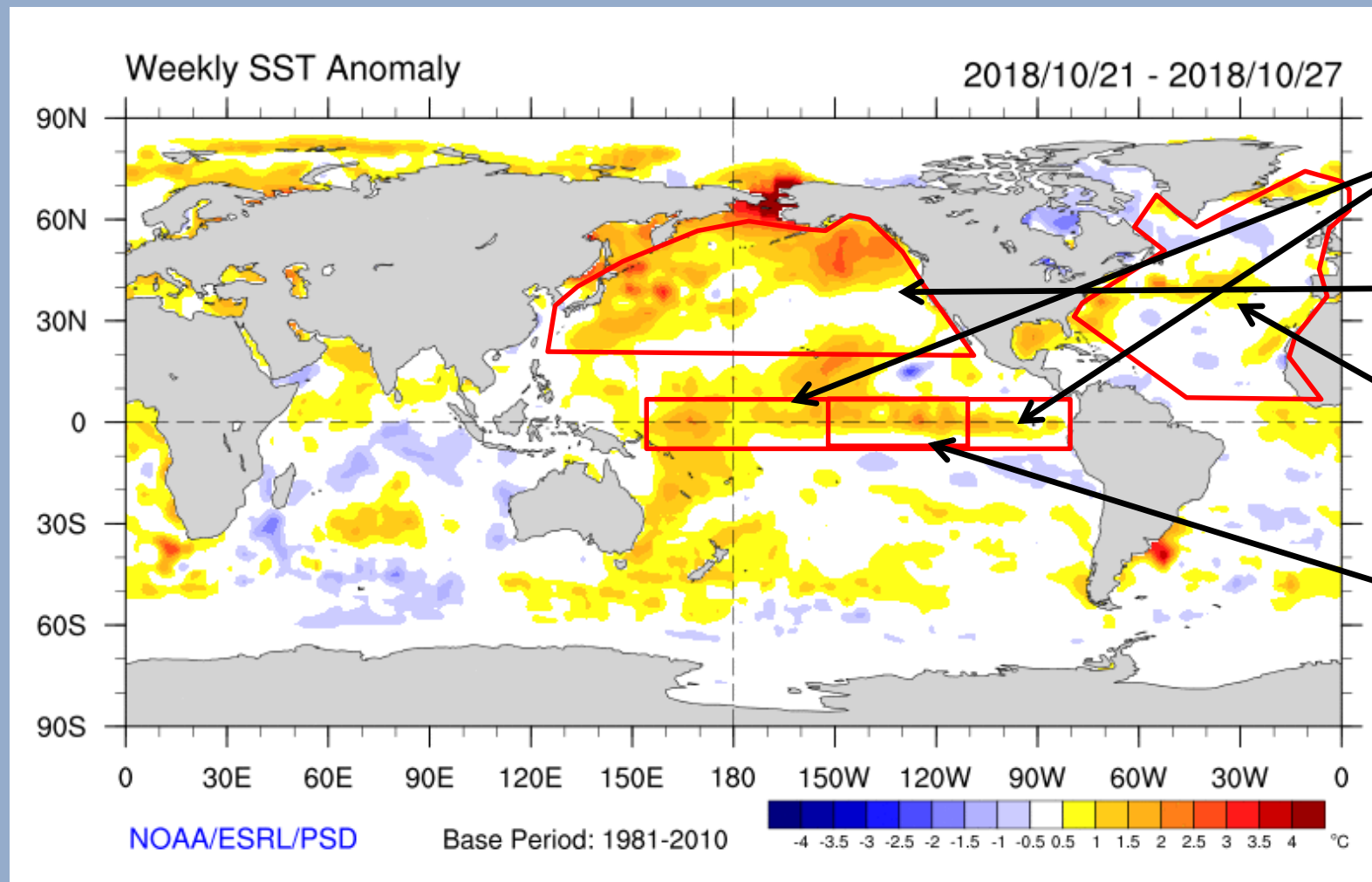
Figure 1. Global Sea Surface Temperature (SST) anomalies from late October 2018. Orange/red color depicts above average temperatures and blue depicts below average temperatures. SSTs along the eastern equatorial Pacific have continued to trend warmer than average the past several months, possibly toward a weak to moderate El Niño.

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Latest Sea Surface Temperature Observations & Oscillation Index Values



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➤ Multivariate ENSO Index (MEI)
for AUG_SEP 2018: **+0.509**

➤ Pacific Decadal Oscillation (PDO)
for SEP 2018: **+0.09**

➤ Atlantic Multidecadal Oscillation (AMO)
for SEP 2018: **+0.161**

➤ Oceanic Niño Index (ONI)
(uses Niño 3.4 region - inner rectangle) for JAS 2018: **+0.1**

Figure 2. Latest weekly global SST anomalies showing warmer than average temperatures in much of the eastern equatorial Pacific Ocean.

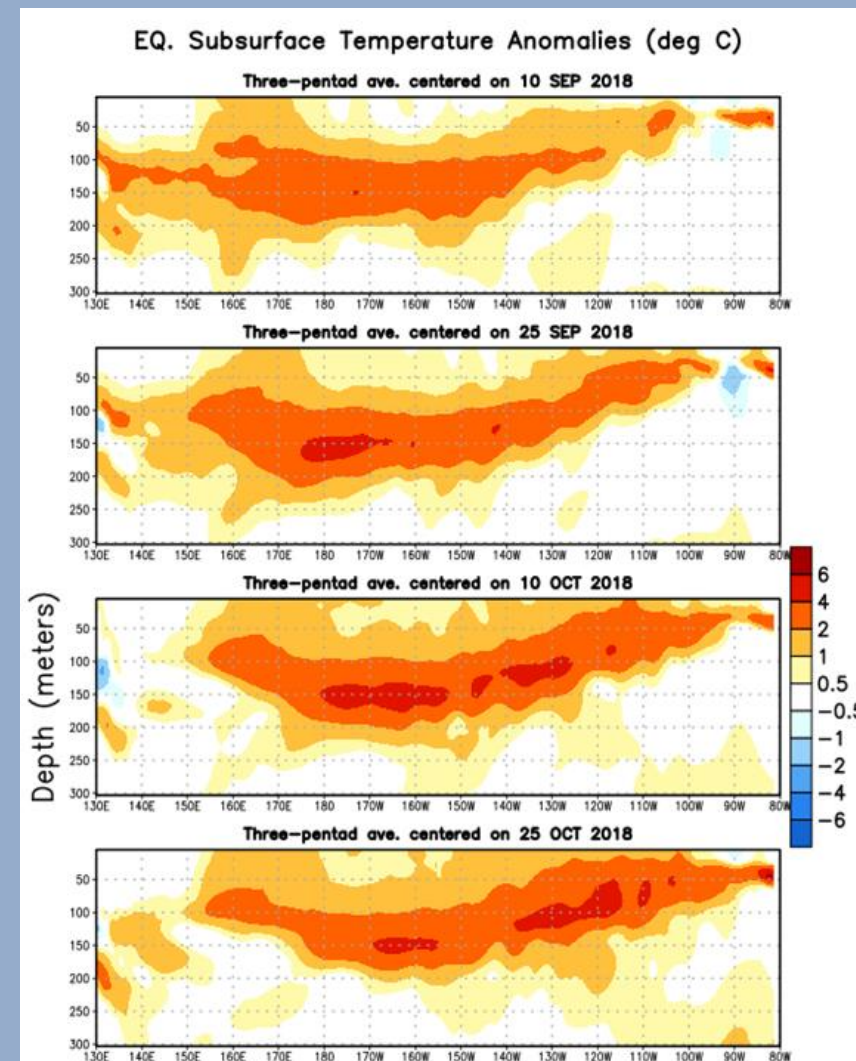
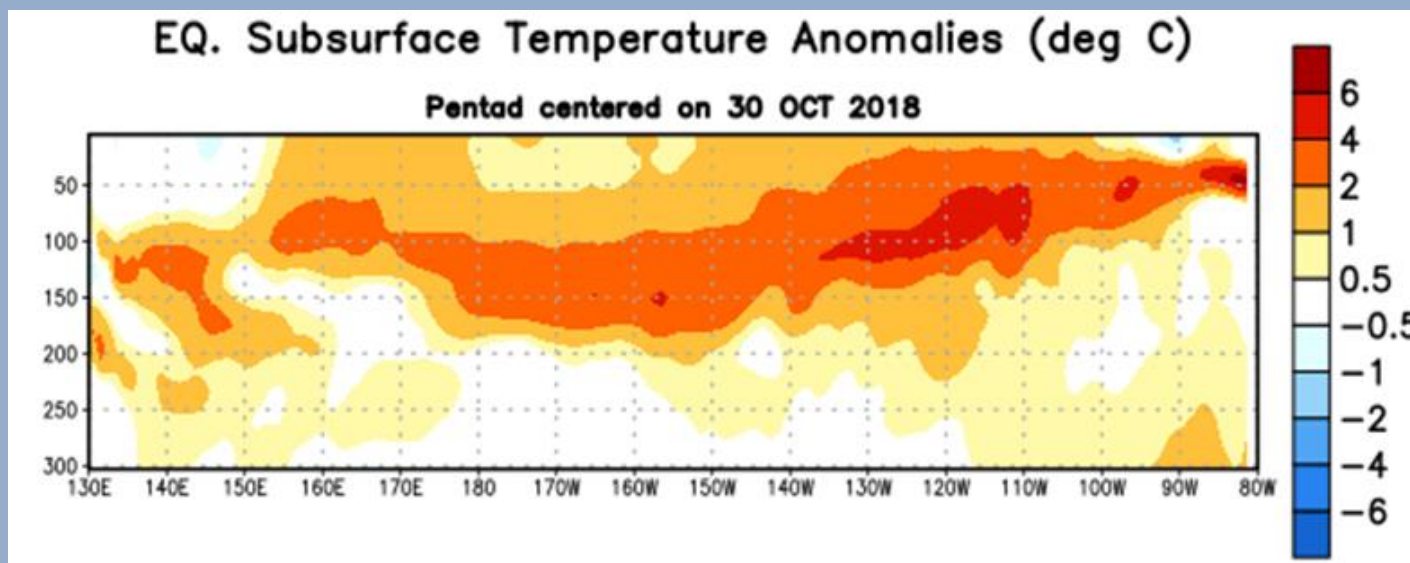
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Sub-Surface Temperature Departures in the Equatorial Pacific



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Figures 3 & 4. Positive subsurface temperature anomalies from the central Pacific have intensified and spread east since late August.

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The Role of Trade Winds with El Niño



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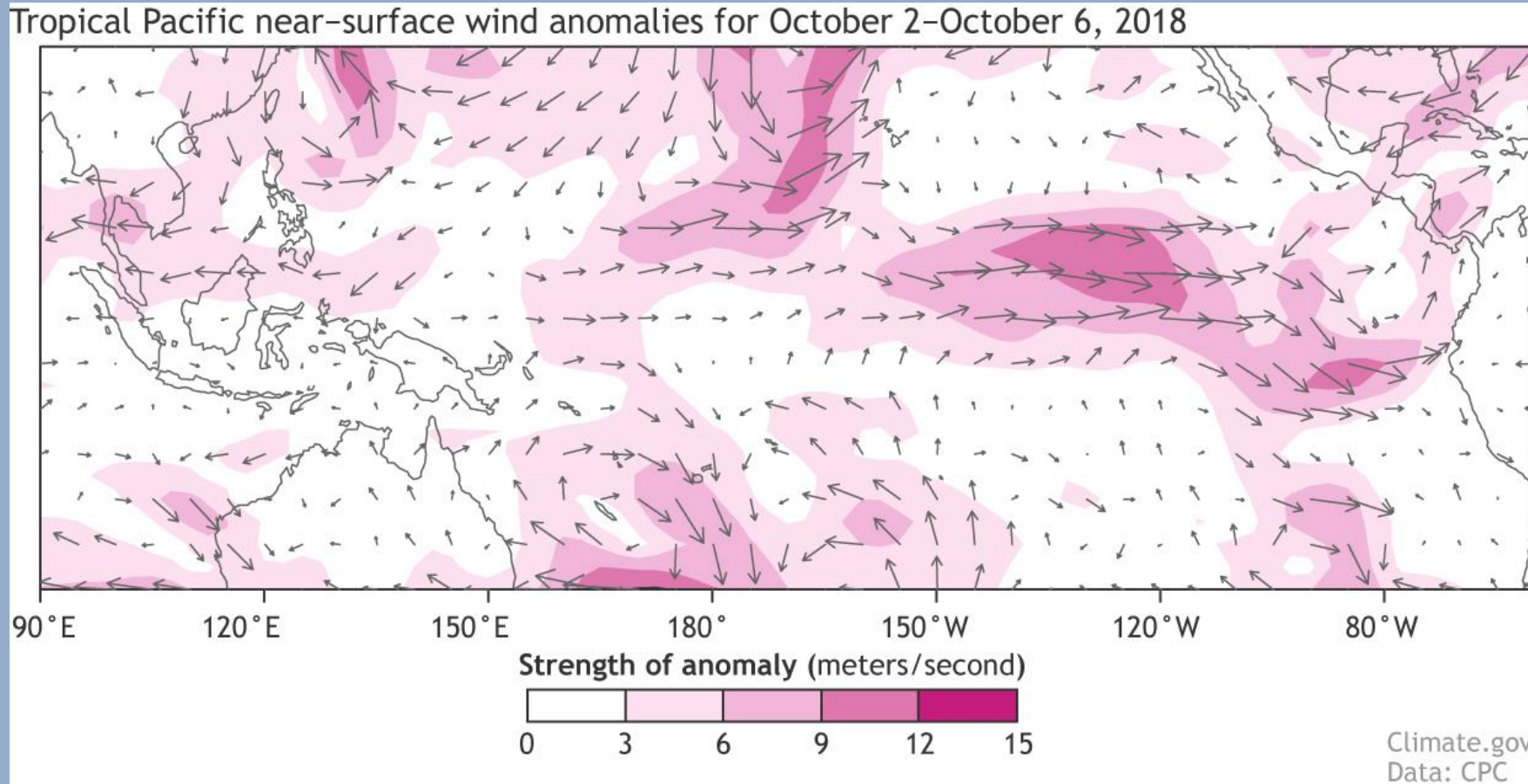


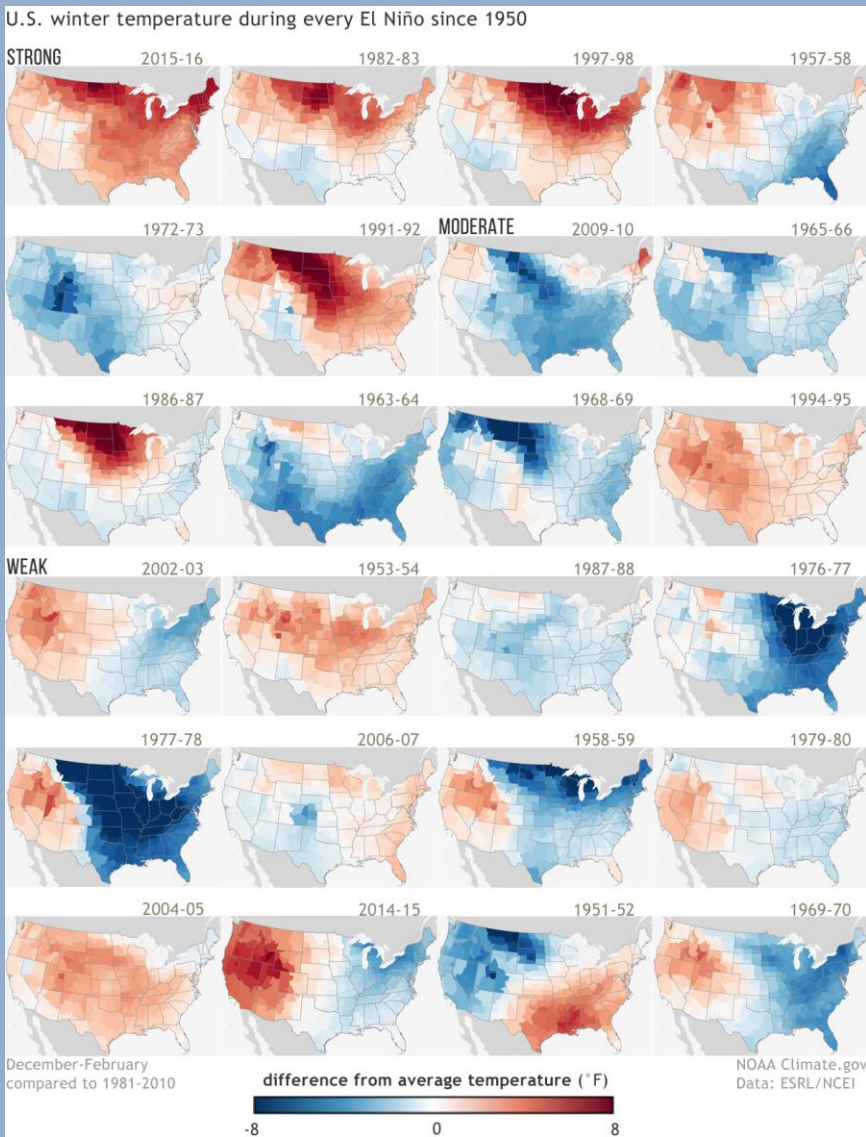
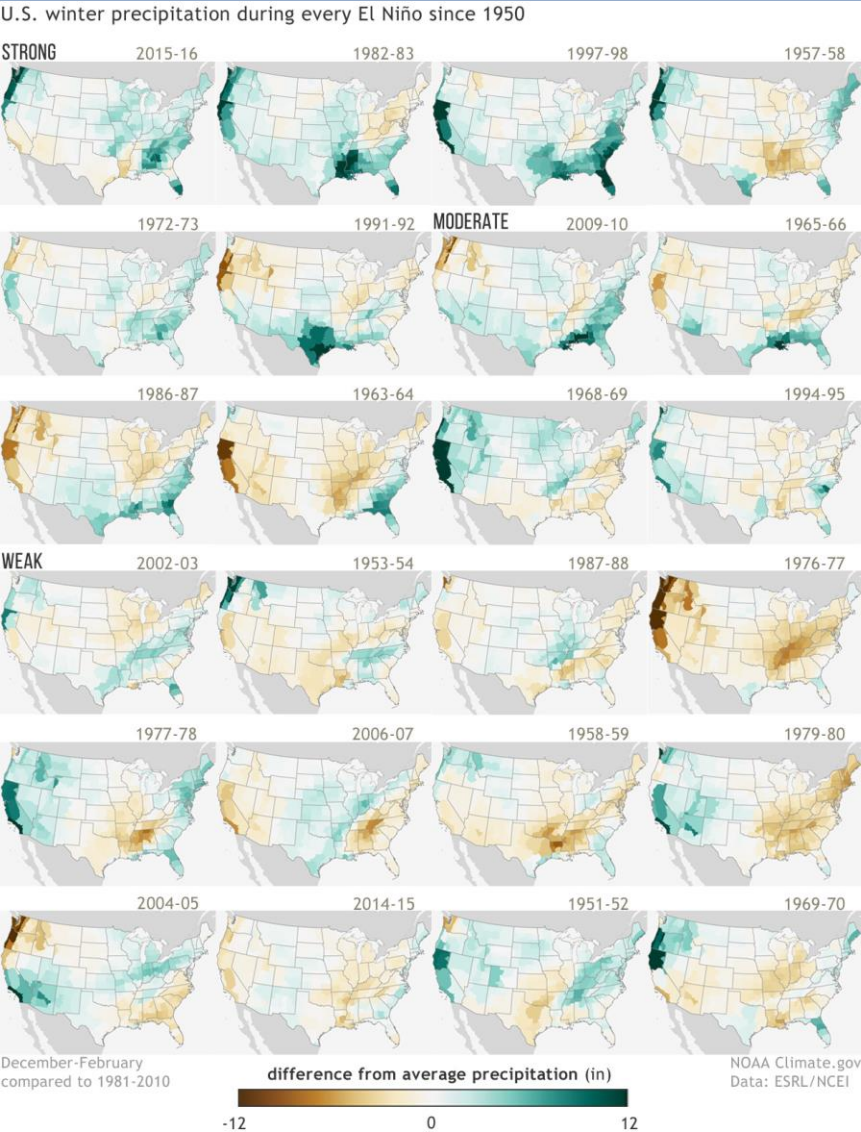
Figure 5. Trade winds normally blow from east to west (“east” winds) along the equator in the Pacific Ocean. These winds help bring colder water up from the depths of the ocean to the surface near South America and also pile up warmer water in the far west Pacific, near Indonesia. When these winds slow down, the surface water can warm, and warmer waters from Indonesia begin to slosh eastward (a downwelling Kelvin wave). It takes a few months for the warm blob of water to travel across the Pacific, and when it reaches the coast of South America, the blob can rise to the surface, providing a months-long source of warmer water to the surface. It’s worth noting that one of the strongest such episodes of the trade winds slowing down and reversing during Sept/Oct since 1979 occurred this year. 1979 is when real-time re-analysis data records began.

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El Niño Events Since 1950 & Anomalous Precipitation/Temperature



Figures 6 & 7. Difference from average precipitation (inches) and temperature (F) during winter from twenty four El Niño events using the Oceanic Niño Index (ONI) since 1950. Weak to moderate El Niño events characteristically are cooler and wetter than average for New Mexico.

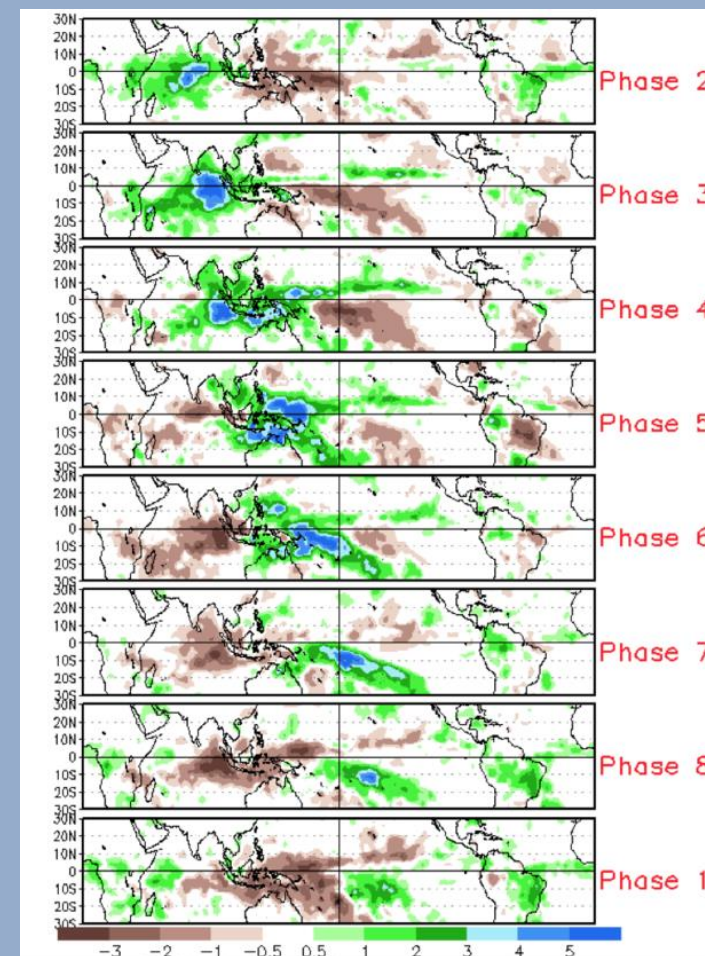
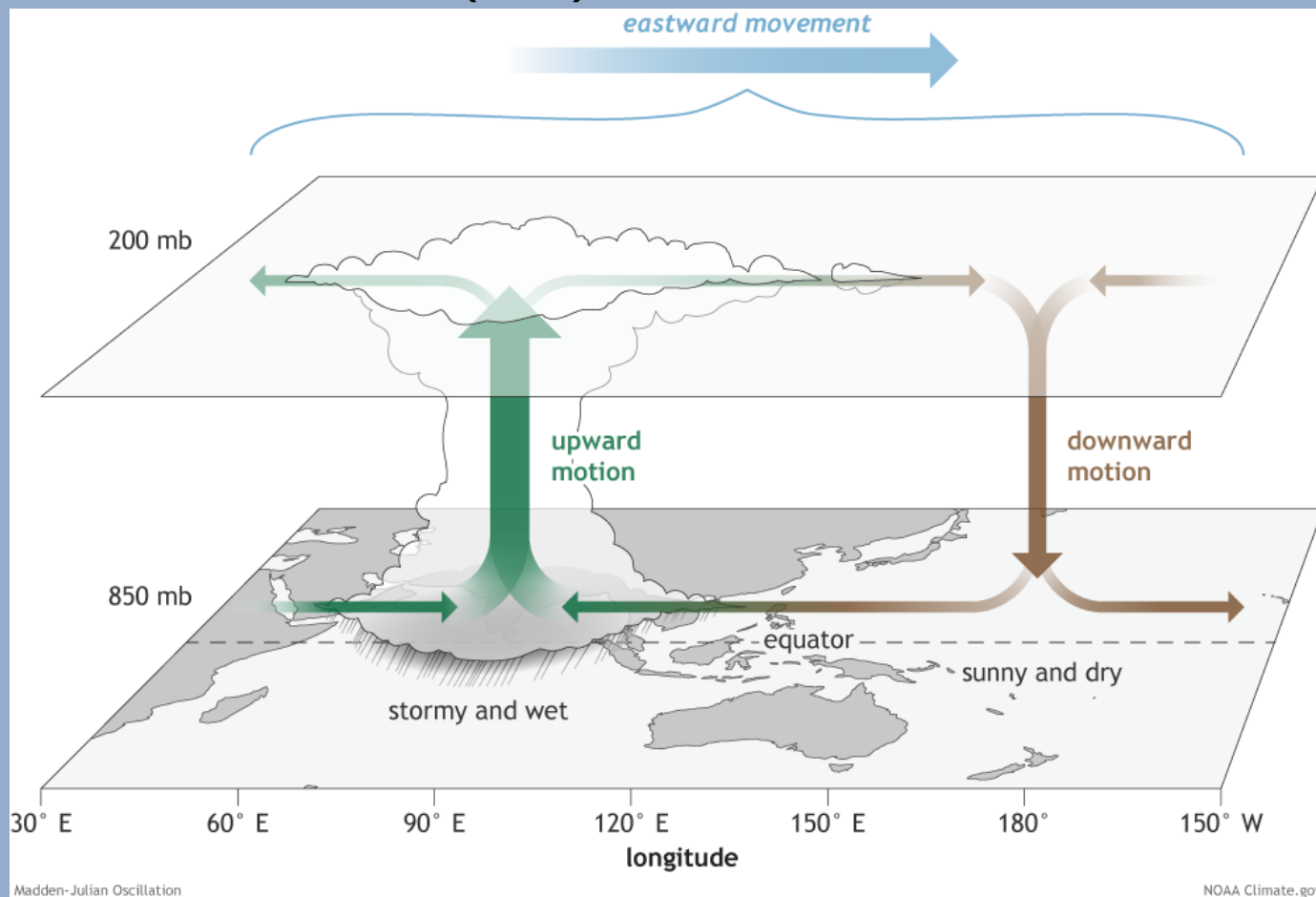
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Madden-Julian Oscillation (MJO) and El Niño



Figures 8 & 9. The MJO is an area of enhanced thunderstorms that travels around the world every 30 to 60 days from west to east along/near the equator. Ahead and behind the active stormy area are areas of suppressed convection and drier conditions. The MJO affects near-surface wind patterns, because the rising air in the stormy area causes surface winds to blow toward the active area. During a developing El Niño, the trade winds are weaker than average, warming up surface waters (vice versa during La Niña). If the MJO is active/strong, it typically changes the wind patterns temporarily and helps either and El Niño or La Niña develop.

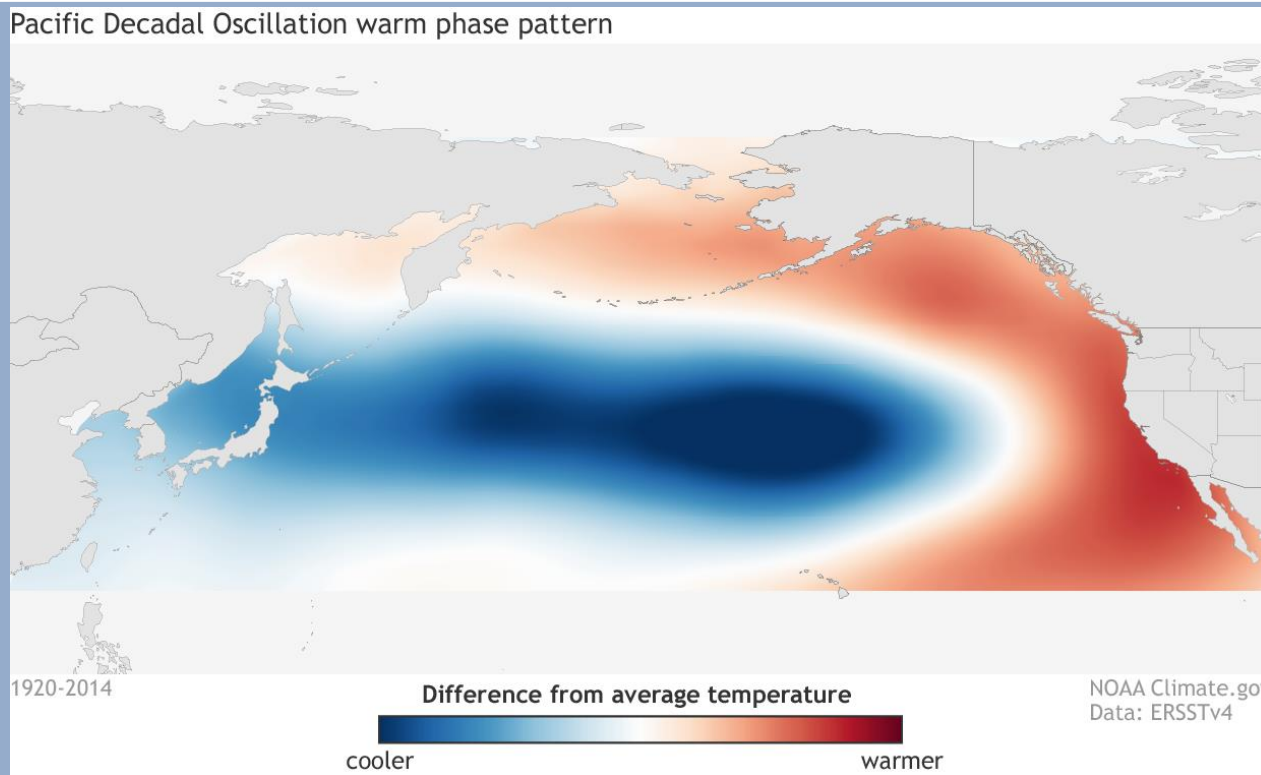
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The Pacific Decadal Oscillation (PDO)



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A key factor during a positive PDO is increased low-level moisture availability in far northeast Pacific/Gulf of CA.



PDO Aug, Sep, Oct 2018	PDO Aug, Sep, Oct 2009	PDO Aug, Sep, Oct 2006	PDO Aug, Sep, Oct 2004	PDO Aug, Sep, Oct 1994	PDO Aug, Sep, Oct 1991
0.18, 0.09, ??	0.09, 0.52, 0.27	-0.65, -0.94, -0.05	0.85, 0.75, -0.11	-0.79, -1.36, -1.32	0.36, 0.65, 0.49

Figure 10. Typical Sea Surface Temperature Anomaly (SSTA) patterns in the North Pacific Ocean during a positive Pacific Decadal Oscillation phase (PDO). As with ENSO, the PDO correlates well with winter precipitation in the southwest United States.

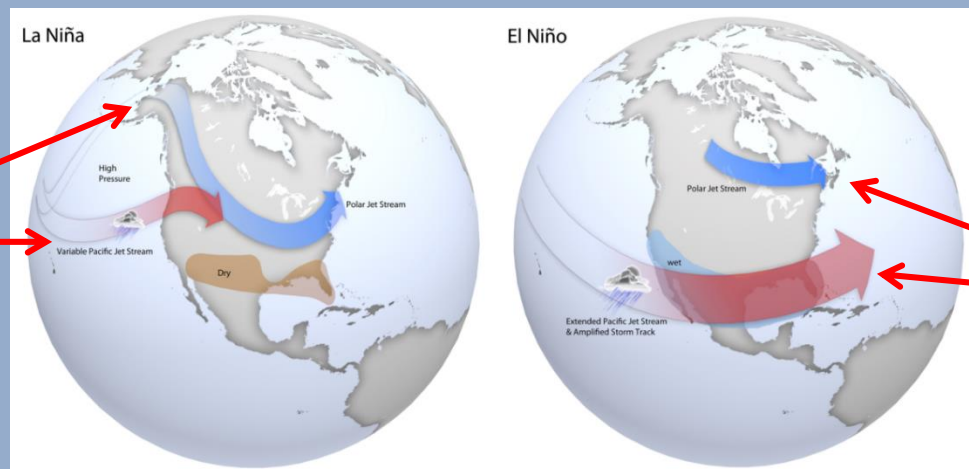
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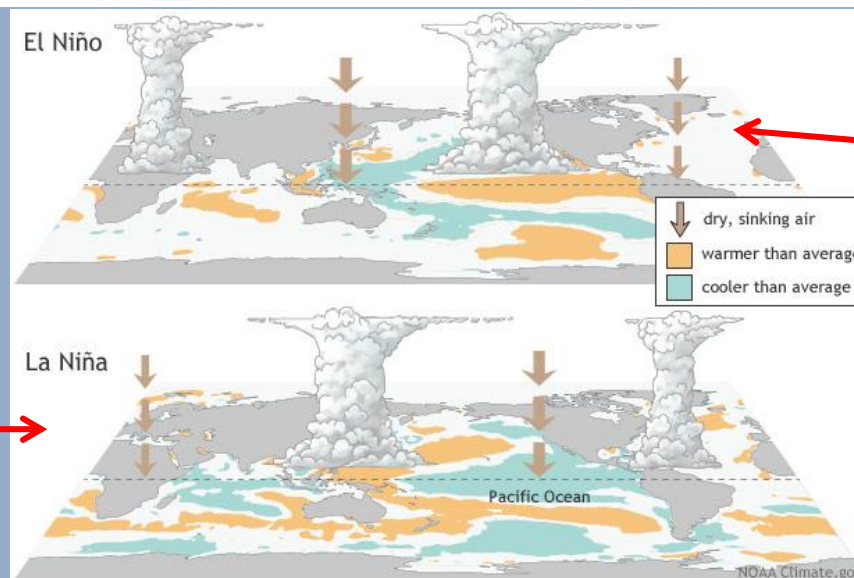
Why SSTs in the Eastern Pacific Ocean Are So Important WRT to Climate

Typical Jet
Stream Pattern
during La Niña



Typical Jet
Stream Pattern
during El Niño

Typical Tropical
circulations
during La Niña



Typical Tropical
circulations
during El Niño

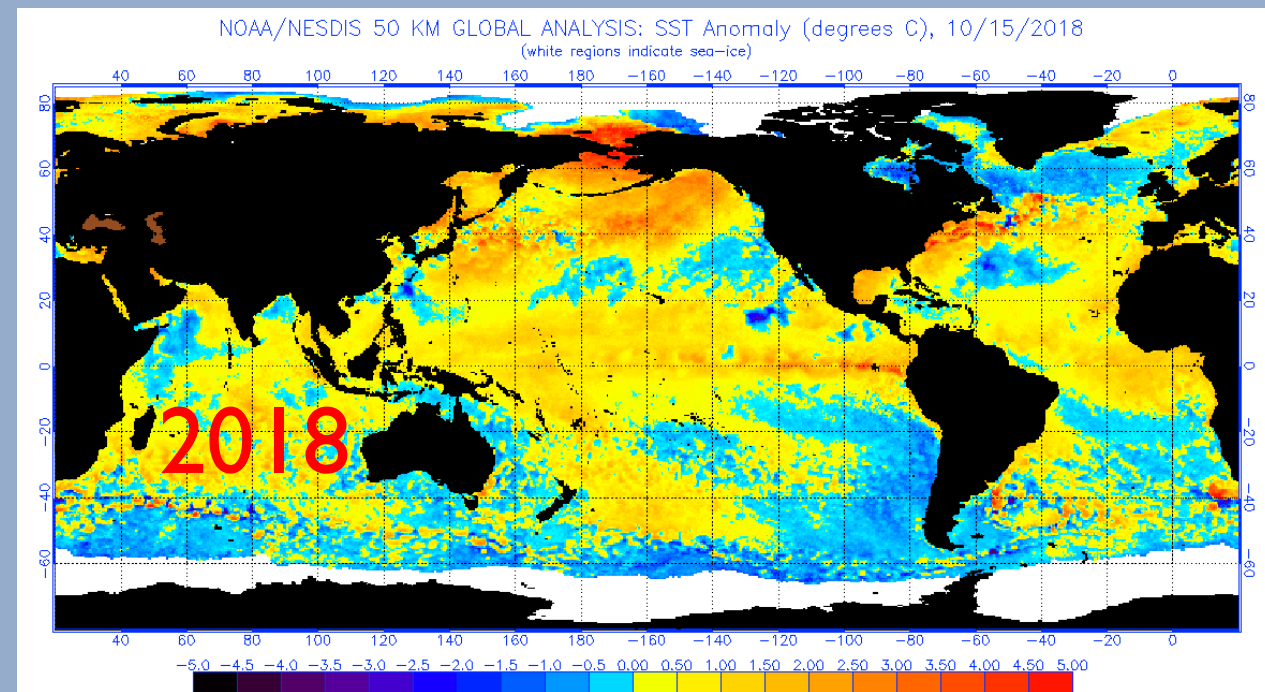
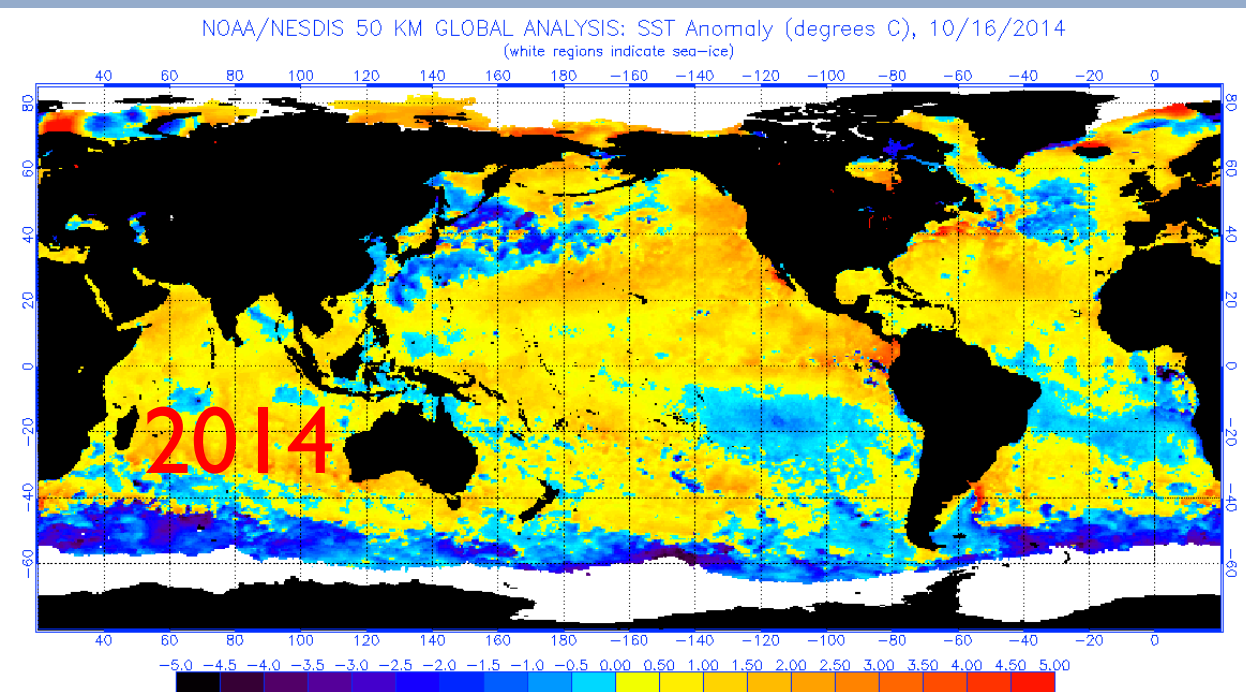
Figures 11 & 12. Warmer SSTs support deep tropical and subtropical convection farther east than average. This deep convection draws the jet stream farther south into the far eastern Pacific Ocean and southwestern United States during El Niño. The opposite is true during moderate to strong La Niñas and the polar jet stream generally remains north of New Mexico. Weak La Niñas are sometimes wetter and cooler than average.

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Comparing Mid October 2014 Global SSTAs to Mid October 2018



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Figures 13 & 14. SSTAs from the most recent weak El Niño event, 2014-15, and current conditions. Note the differences in the north Pacific.

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DJF Precipitation Anomaly “Analog” Winters



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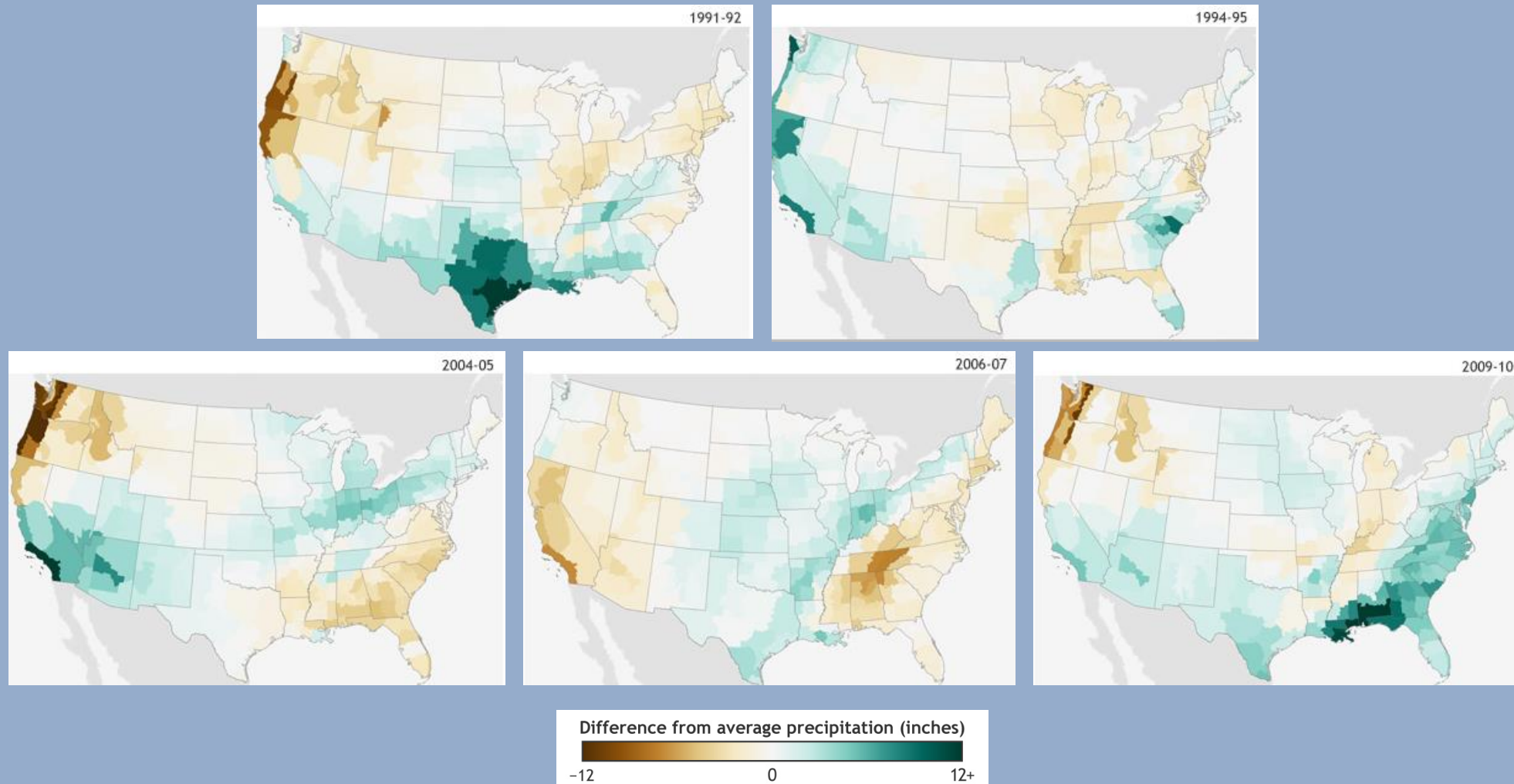


Figure 15-19. December-February precipitation compared to the 1981-2010 average during five weak to moderate El Niño winters through 2010. Each event was considerably different despite similar SST anomalies in the equatorial Pacific.

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All Weak El Niño Winters Since 1950



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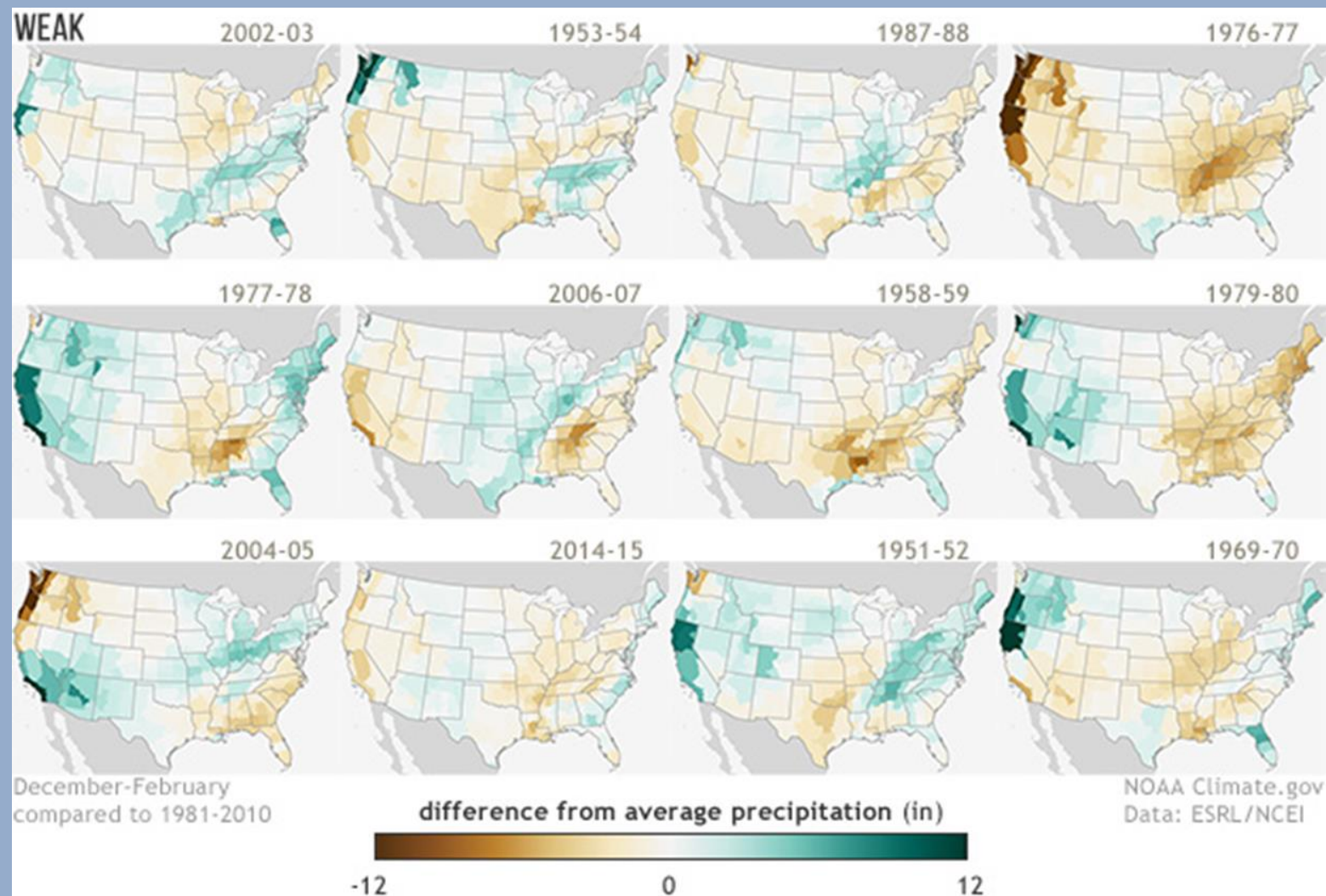


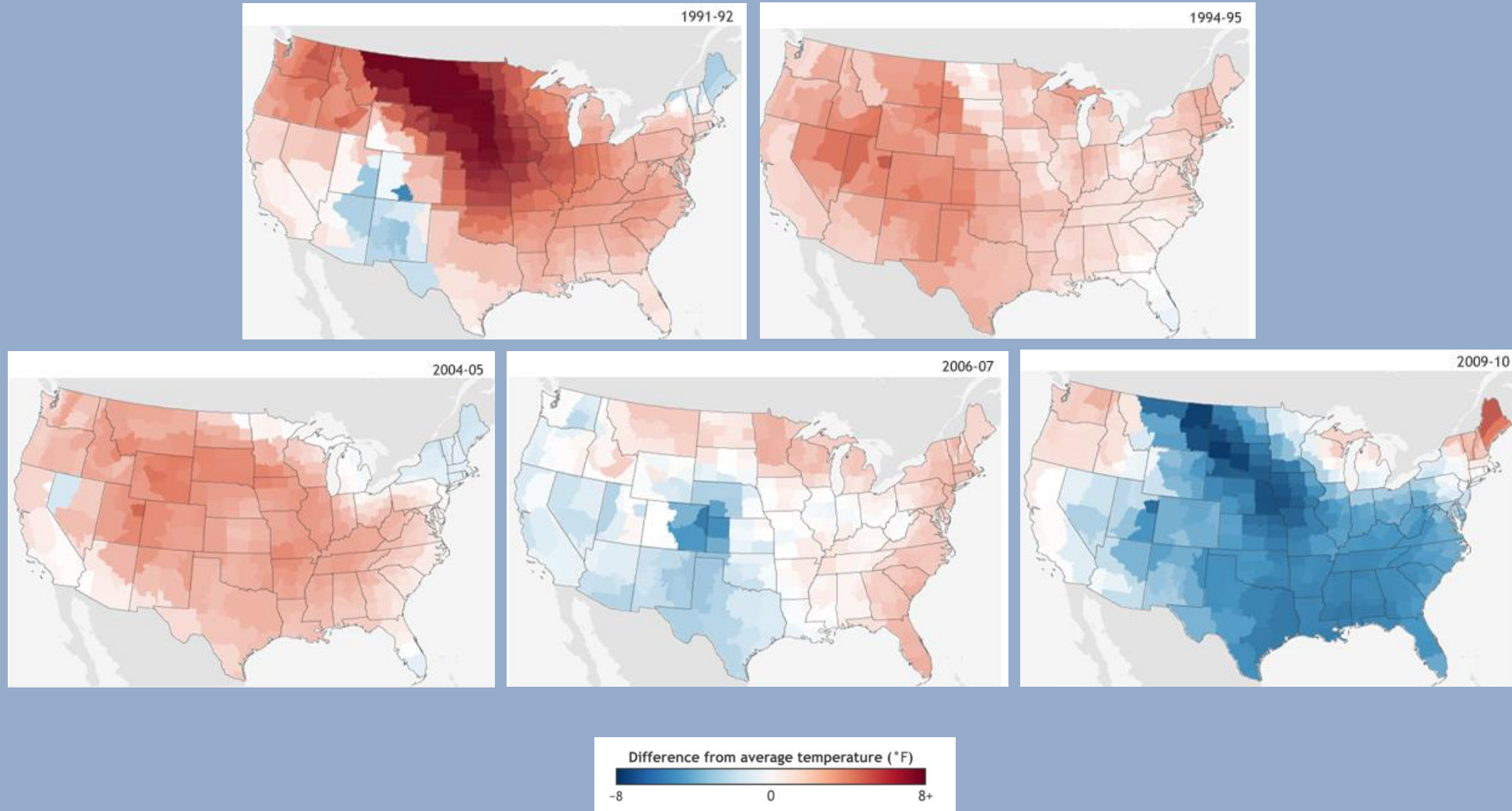
Figure 20. Precipitation anomalies during all 12 weak El Niño events since 1950. Precipitation during the majority of events ended up at least slightly above average.

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DJF Temperature “Analog” Winters



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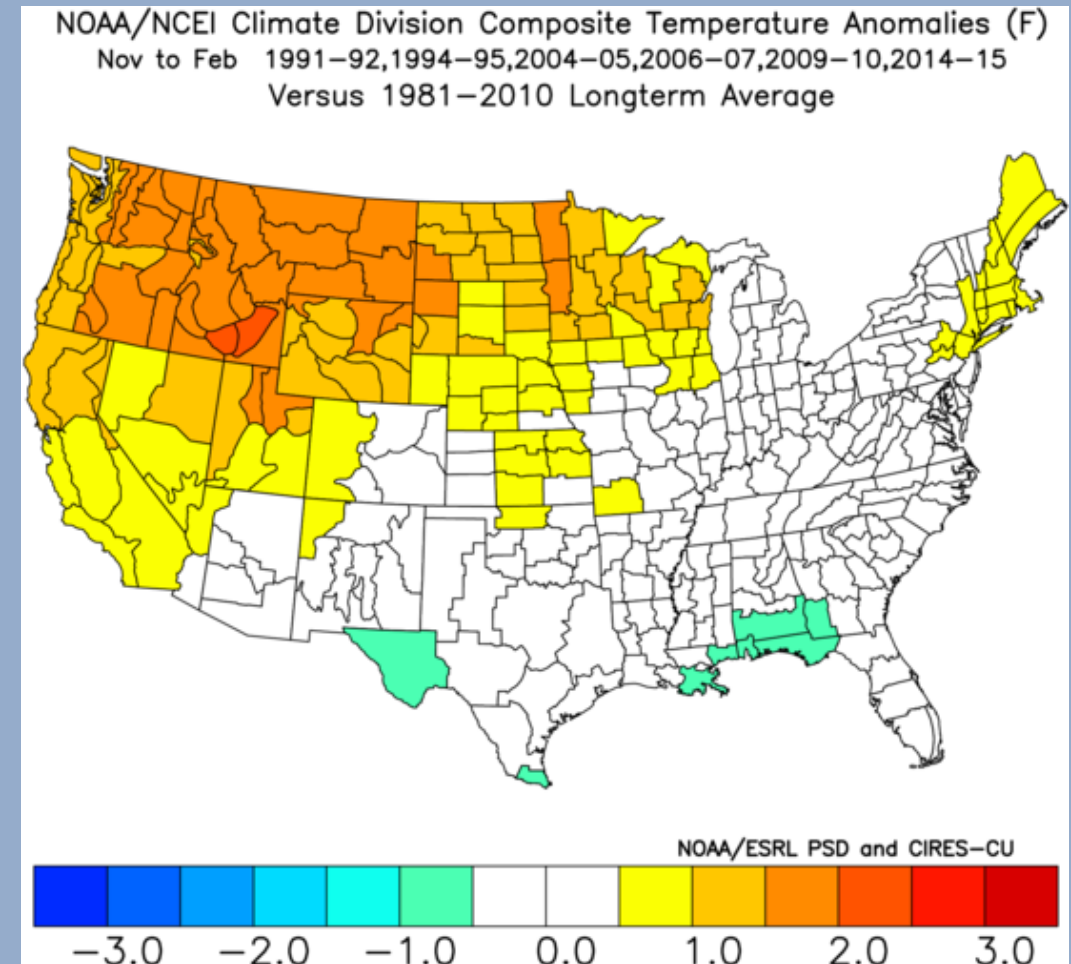
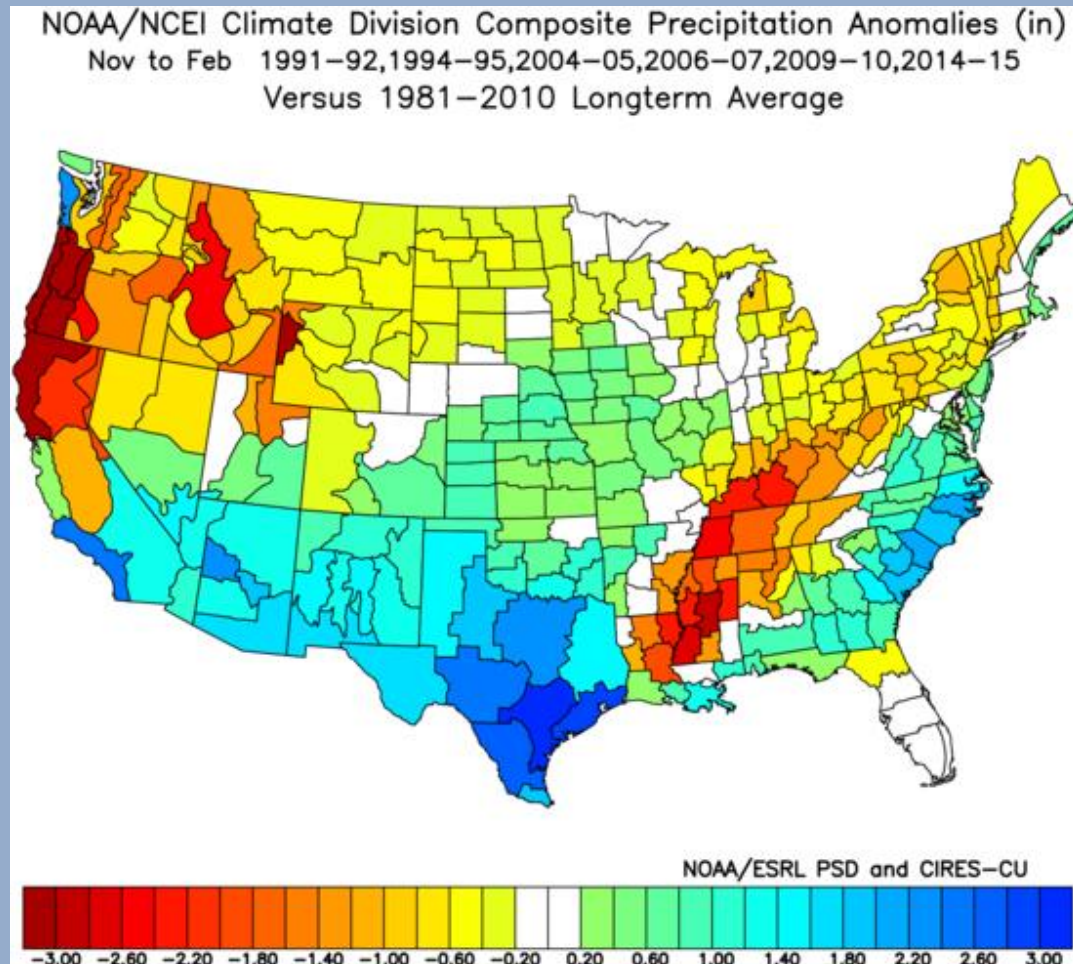
Figures 21-25. December-February temperatures compared to the 1981-2010 average during each weak El Niño winter since records began in 1950. Again, each event was different despite similar SST anomalies.

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Precipitation and Temperature Anomalies



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Figures 26 & 27 . DJF Precipitation and Temperature anomaly plots for CPC's climate divisions comparing five analog seasons (1991-92, 1994-95, 2004-05, 2006-2007, 2009-10 & 2014-15) with 30-year climatological averages. Five climate divisions in the state were near to below average for precipitation while the northern three divisions were very near average with regard to precipitation. Temperatures were slightly below to below 1981-2010 climatological averages.

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Averaging All 21 El Niño Events Since 1950



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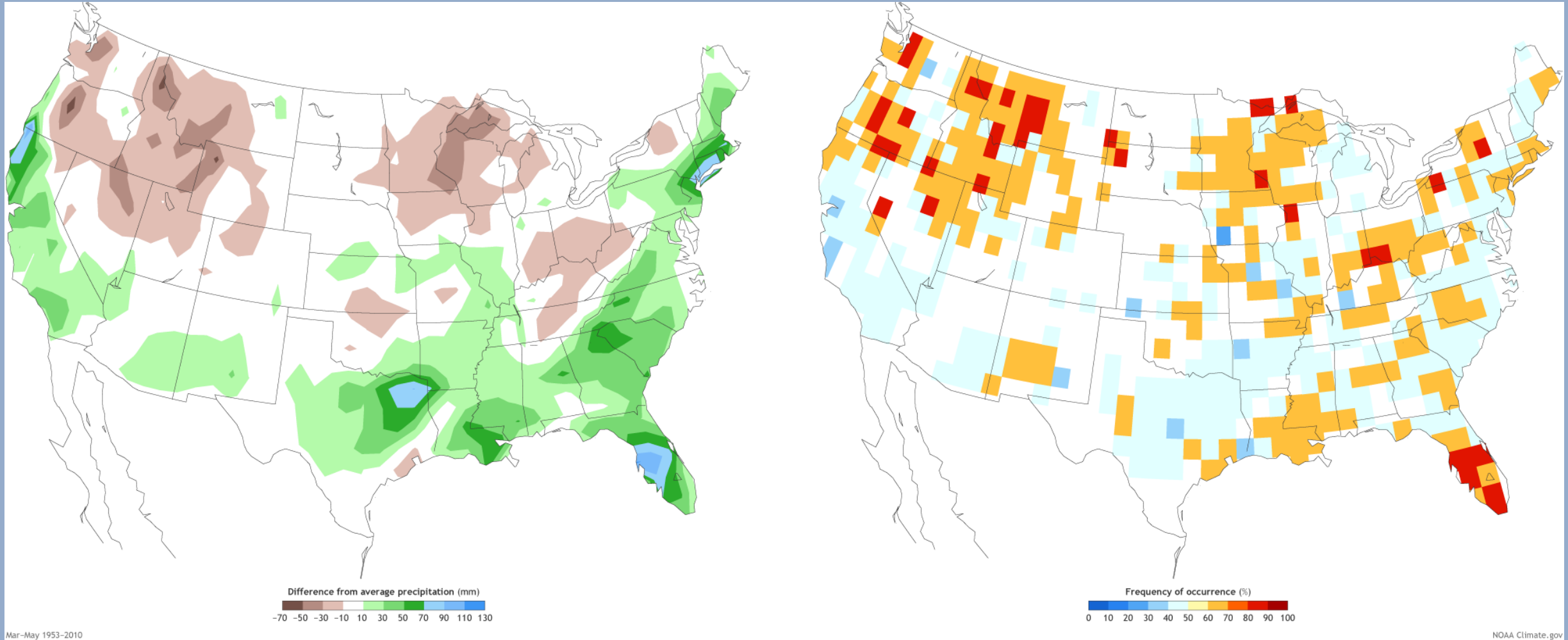


Figure 28. Precipitation anomaly averaged from all 21 El Niño events since 1950 along with frequency of occurrence.

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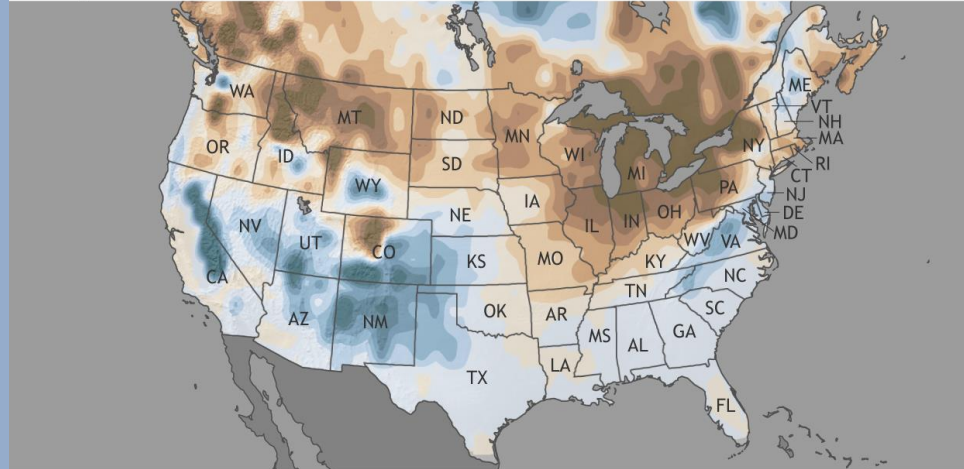
El Niño and Snow



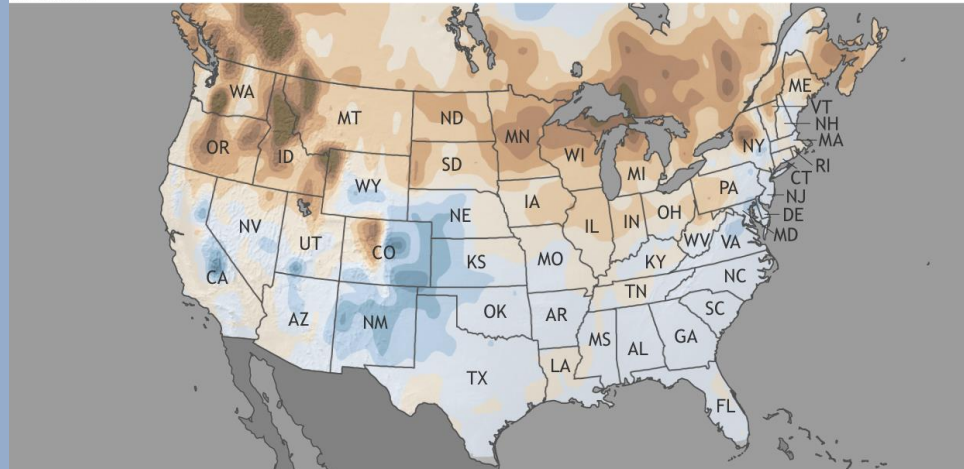
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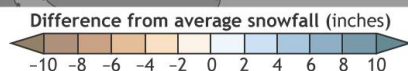
Snow during El Niño winters (1950–2009)
10 strongest events



All events

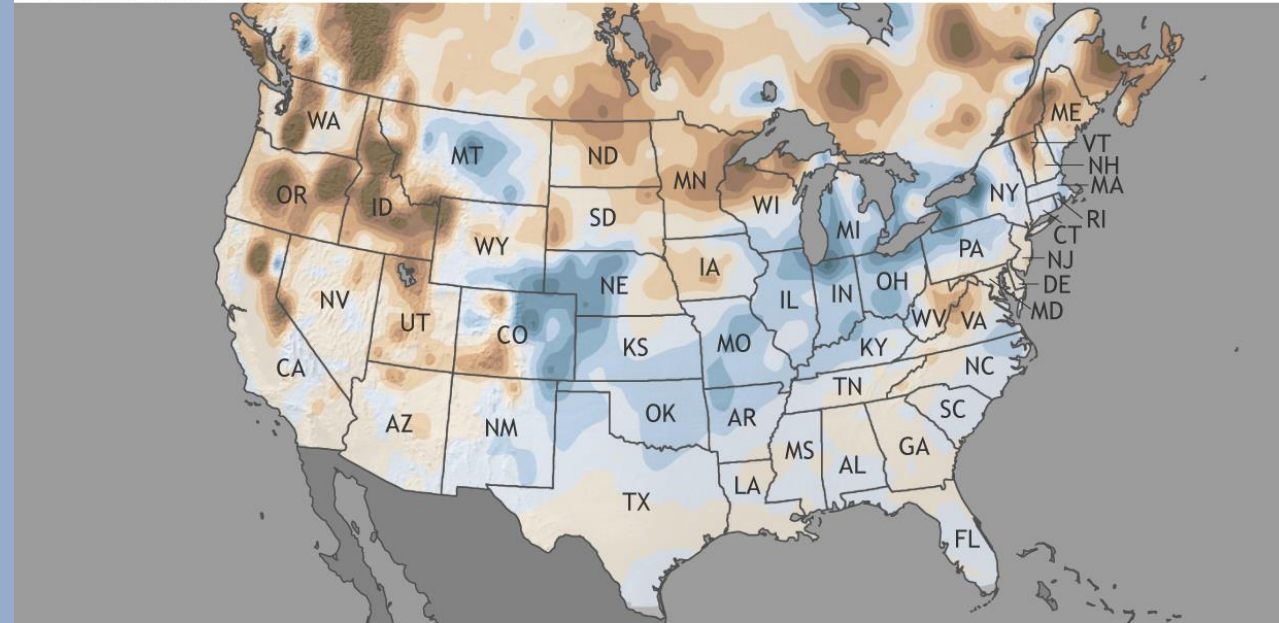


October–April
compared to 1950–2009

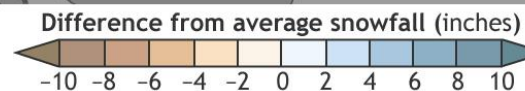


NOAA Climate.gov
Data: Rutgers/CPC

Snow during El Niño winters (1950–2009)
10 weakest events



October–April
compared to 1950–2009



NOAA Climate.gov
Data: Rutgers/CPC

Figures 29 & 30. Snow anomalies from October to April 1950–2009 during different flavors of El Niño.

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Latest Climate Model Forecasts



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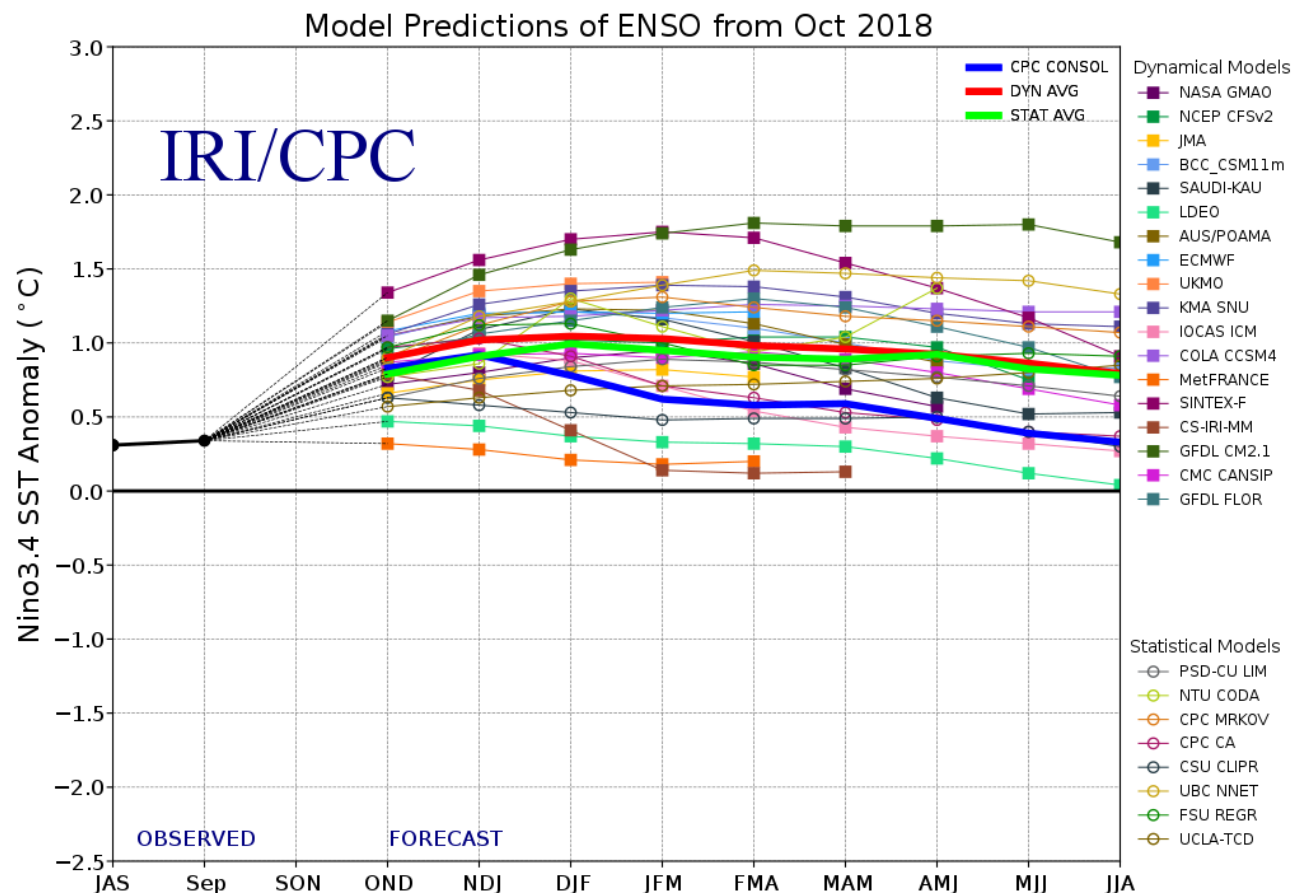


Figure 31. Vast majority of climate models develop a weak to moderate El Niño ($\sim -0.5^{\circ}\text{C}$) in during the Northern Hemisphere winter (DJF) 2018-19 and keep in going through at least summer 2019.

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Climate Prediction Center's Official 2017-18 Winter Outlook



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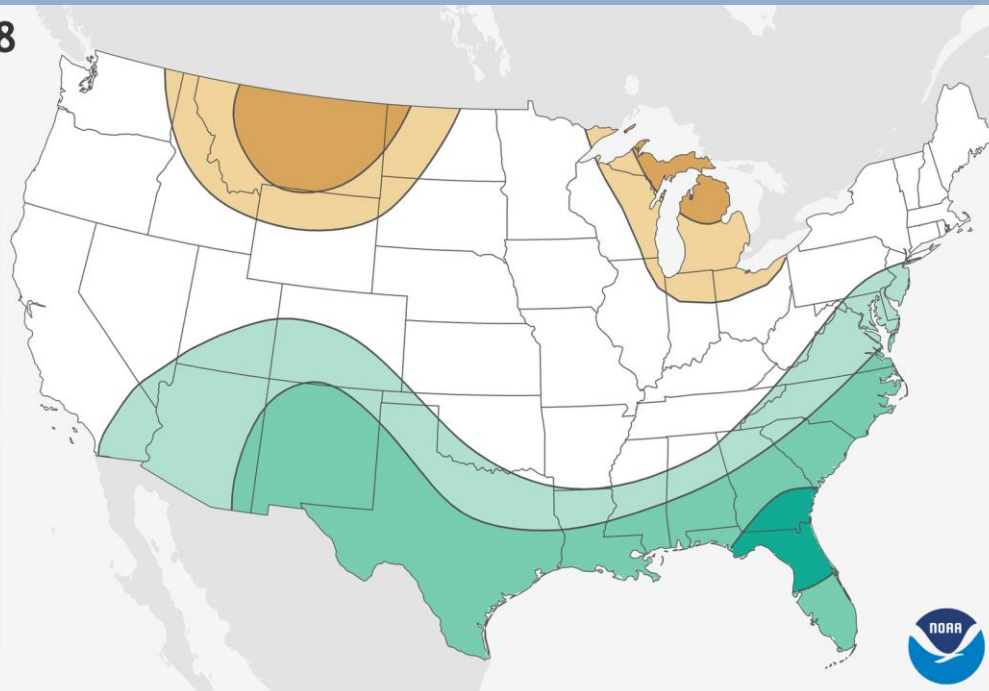
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Winter 2018

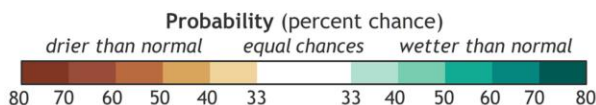
U.S.
Precipitation
Outlook



AK and HI not to scale



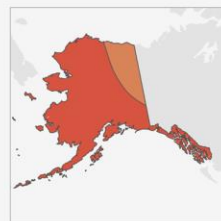
Precipitation Outlook
for Dec 2018 – Feb 2019
Issued 18 October 2018



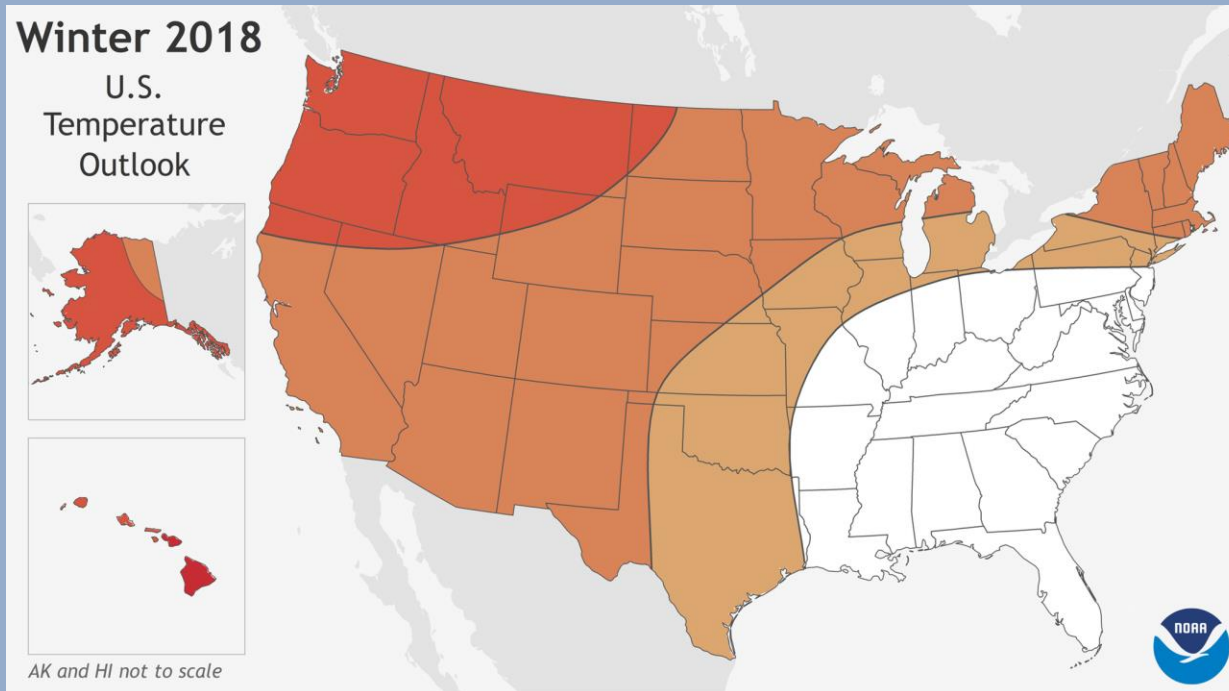
NWS Climate Prediction Center
Map by NOAA Climate.gov

Winter 2018

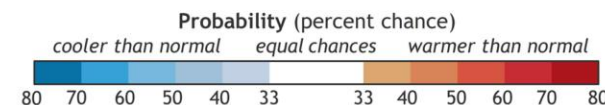
U.S.
Temperature
Outlook



AK and HI not to scale



Temperature Outlook
for Dec 2018 – Feb 2019
Issued 18 October 2018



NWS Climate Prediction Center
Map by NOAA Climate.gov

Figures 32 & 33. CPC's DJF 2018-19 precipitation and temperature forecasts favoring above average precipitation and above average temperatures for all of New Mexico.

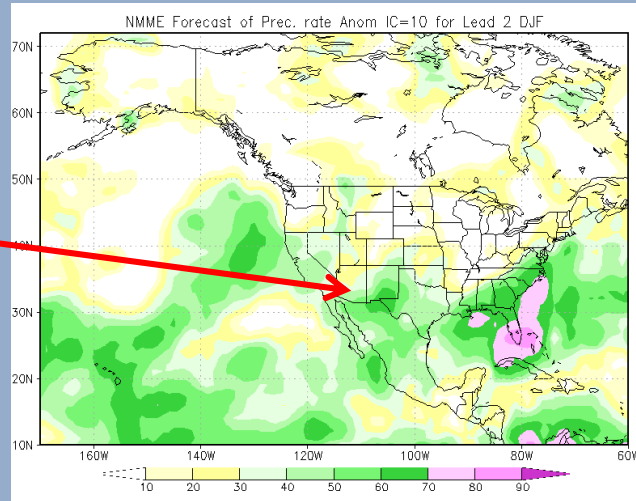
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Numerical Climate Prediction Model Precipitation for DJF

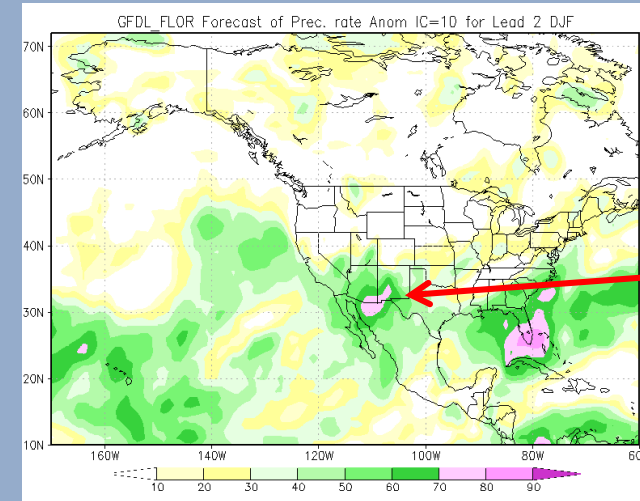


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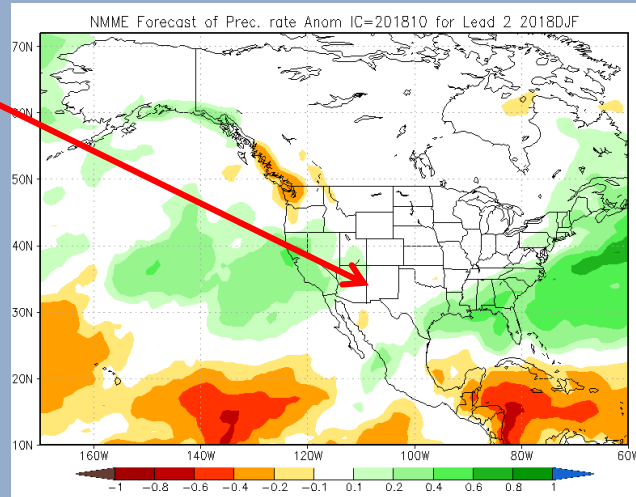
Highest model skill in DJF
across southern NM.



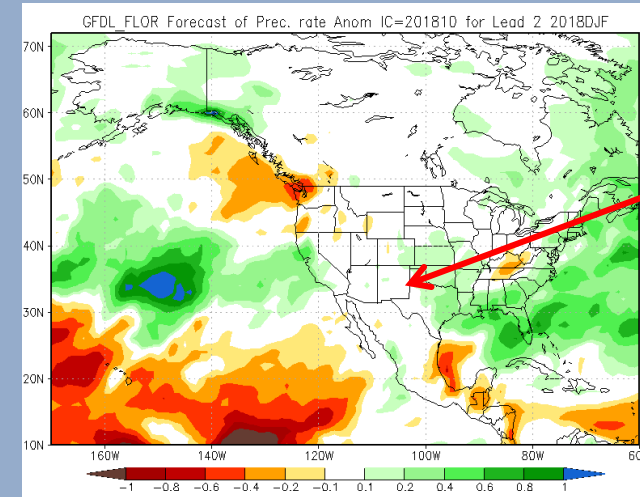
Highest model skill in DJF
across southern NM.



White equates to average
precipitation rates.



White equates to average
precipitation rates.



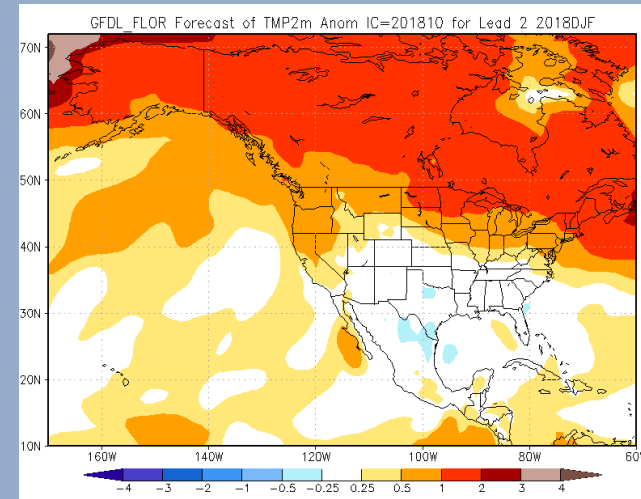
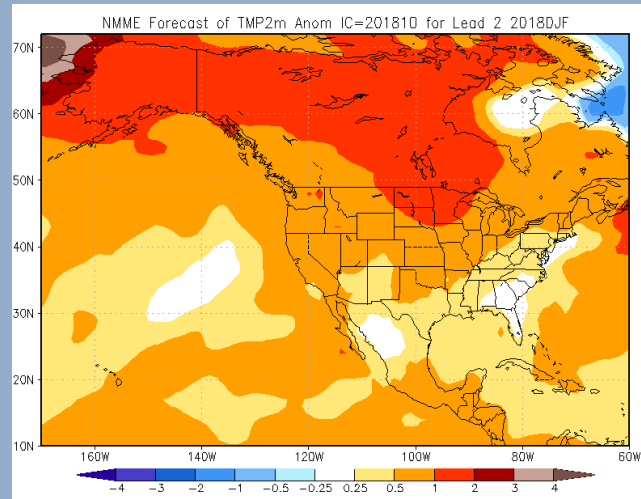
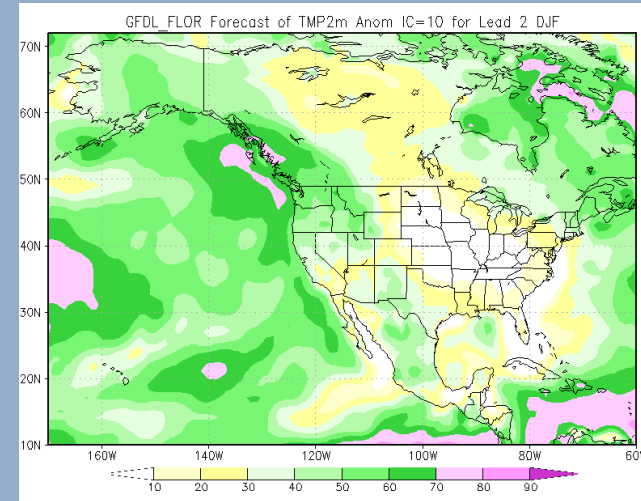
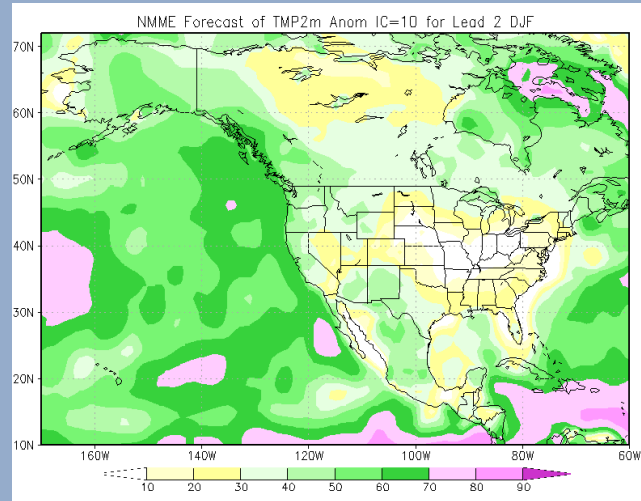
Figures 34-37. Model precipitation rate anomaly plots from the two climate models which have the highest skill percentages (top two images), the North American Multi-Model Ensemble (NMME) and the Geophysical Fluid Dynamics Laboratory (GFDL_FLOR) model. Both model forecasts are predicting average precipitation for DJF 2018-19 across New Mexico.

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Numerical Climate Prediction Model Temperatures for DJF



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Figures 38-41. Two meter (6.5 feet above ground level) temperature anomaly forecasts from the two climate models which have the highest forecast skill percentages, the North American Multi-Model Ensemble (NMME) and the Geophysical Fluid Dynamics Laboratory (GFDL_FLOR) model. Both models forecast slightly above to above average temperatures during DJF 2018-19 across New Mexico.

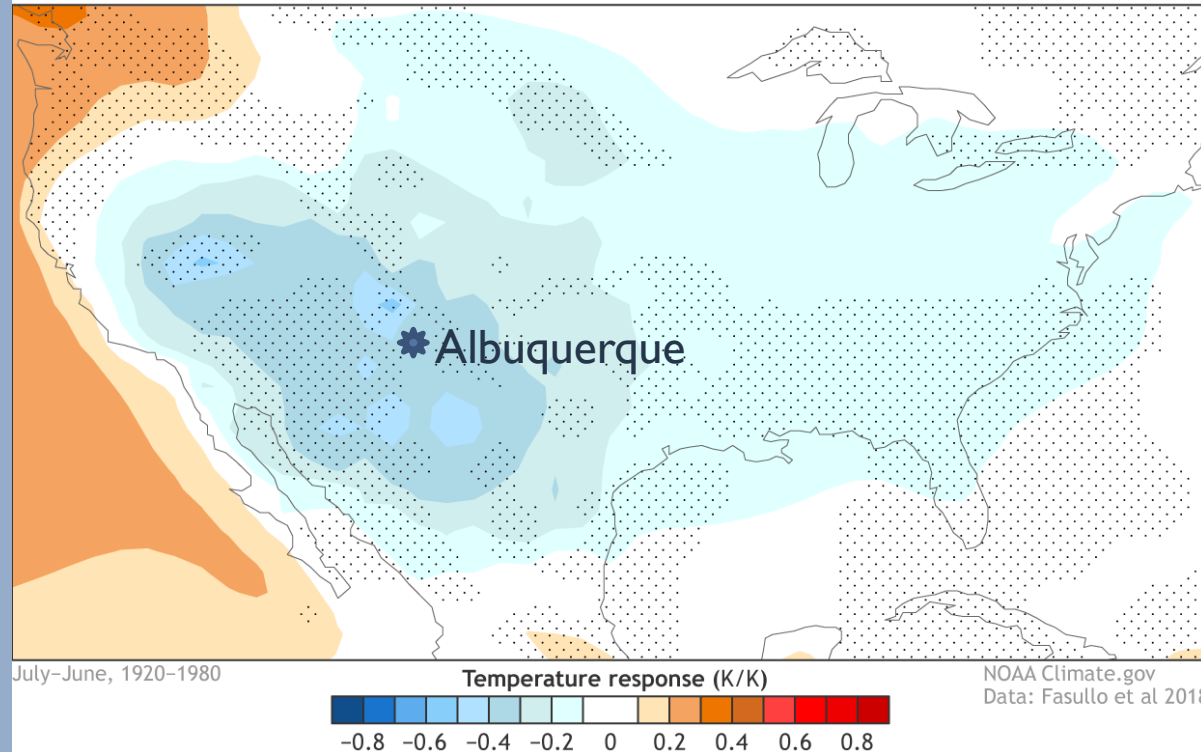
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Future El Niño Temperature Trends?

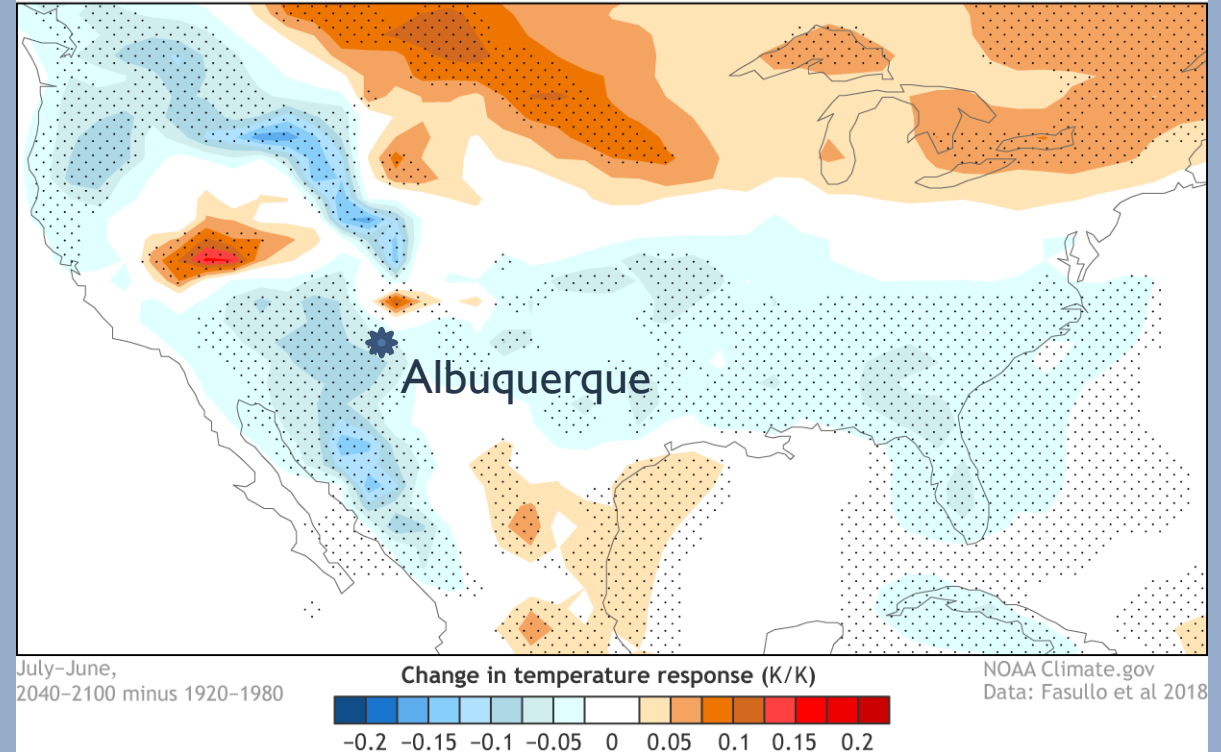


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Temperature response to ENSO in CESM climate model



Change in temperature response to ENSO in CESM climate model



Figures 42 & 43. Temperature responses from the Community Earth System Model (CESM) climate model from 1920-1980 during El Niño events (left) vs. 2040-2100 (right). Model results on the left are close to temperature observations from 1920-1980. Note how the climate model changes the impact of temperature in the future during El Niño events as the planet warms.

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Summary



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- Precipitation in previous winter (DJF) seasons during weak El Niño events since 1950 ranged from near to above the 1981-2010 climatological averages at sites throughout northern and central New Mexico. Past precipitation data also suggests that the southern half of New Mexico stands the best chance of being slightly above to above average during a weak to moderate El Niño event.
- Precipitation data from five previous weak to moderate El Niño events (1991-92, 1994-95, 2004-05, 2006-07, 2009-10) combined with forecasts from the most highly skilled climate forecast models indicate that precipitation in central and northern New Mexico during December, January and February (DJF) 2018-19 will most likely range near to slightly above average 1981-2010 climatological averages.
- Snowfall data from five previous weak to moderate El Niño events suggest that snowfall will range from near to slightly above average amounts in DJF 2018-19. Greatest chances for slightly above average snowfall is across the southern half of the state.
- Temperatures trends from the past 10 El Niño events combined with forecasts from the most highly skilled climate models suggest temperatures will range from slightly above to above average in DJF 2018-19.
- Each El Niño event is different. Typically, a warming central and eastern Pacific Ocean means greater chances of at least average winter precipitation for New Mexico.



- **Outlook provided by National Weather Service Forecast Office Albuquerque, NM.**
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